Center Innovation Fund: JPL CIF

Variable and Adaptive Coded Modulation for Cognitive Networking

Completed Technology Project (2012 - 2013)

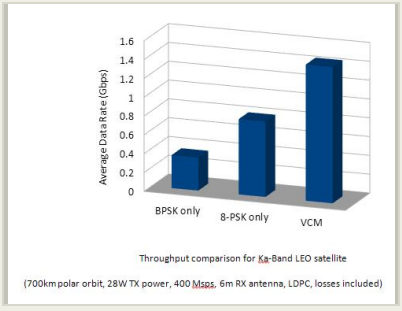
Project Introduction

In this task, our objective is to design and implement a variable coded modulation (VCM) system capable of significantly increasing the data return of Space-to-Earth communications links, compared to non-VCM systems. This meets NASA's goal of more power and spectral-efficient technology, and is an enabling component of cognitive networks.

Background. NASA missions undergo wide variation in communications link conditions. Over the course of months, the range changes dramatically from launch, to cruise, to say, Mars orbit, but link conditions change on much shorter time scales, as well. For example, a typical track of MRO tracked by the Deep-Space Network might start at antenna elevation 11°, rise to 72°, and then fall to 8° over a twelve hour period. Recent and near-future NASA missions have their data rates limited by dynamic effects such as weather (e.g., MRO Ka-band links), solar scintillation (e.g. Solar Probe), on-board interference (e.g., MRO CRISM interference), launch plumes, and other effects. A 2005 Mars Technology Program study reported that up to 50% more data can be returned on a typical Mars-lander to Mars-orbiter link when adaptive data rates are used on the link. Our task is to extend the concept of adaptive data rates to variable and adaptive coded modulation, in which the dynamic power and bandwidth resources can be much more effectively utilized. A 2010 study by ESA determined that in one practical scenario, a VCM system could more than double the total data volume returned. Our task is to make effective use of the CCSDS standard coded-modulations, thereby allowing us to operate close to the unconstrained capacity limit, regardless of link conditions. To do this, we will develop a physical-layer design that allows the transmitter to switch between coded modulations on a codeword-to-codeword basis, a mechanism to inform the receiver which coded modulation is being used, and the receiver tracking structures necessary to identify the coded-modulation and demodulate and decode the data appropriately.

Anticipated Benefits

Variable coded modulation (VCM) and adaptive coded modulation (ACM)has the following benefits: 1. Double a typical NASA mission's total downlink data volume, without increasing required power or bandwidth, by making more efficient use of time-varying resources. This meets NASA's strategic goals of more power and spectral-efficient technology. 2. Enable communication through launch plumes and through plasma during Earth reentry, and in other unpredictable, highly dynamic link conditions.



Project Image Variable and Adaptive Coded Modulation for Cognitive Networking

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

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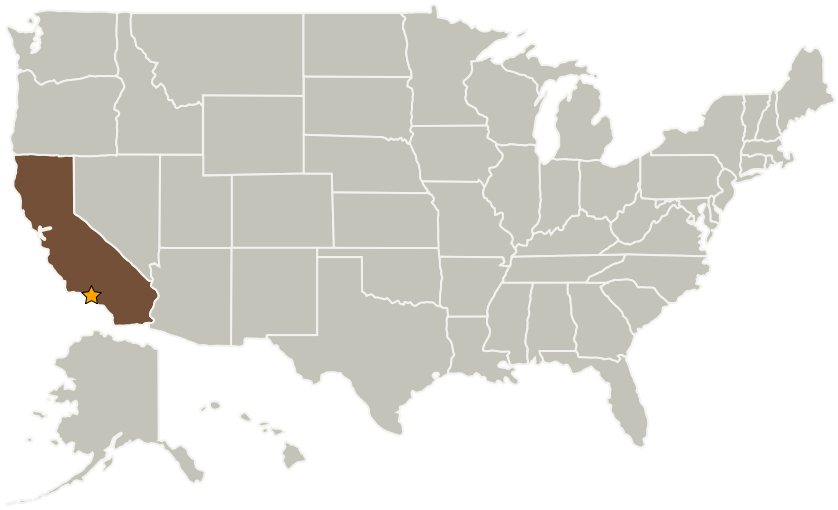
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Michael R Lapointe

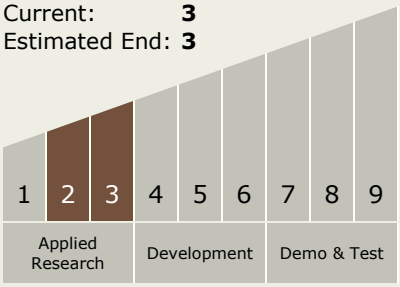
Program Manager:
Fred Y Hadaegh

Project Manager:
Jonas Zmuidzinas

Principal Investigator:
Jonathan Hamkins

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.5 Revolutionary Communications Technologies
    - TX05.5.1 Cognitive Networking

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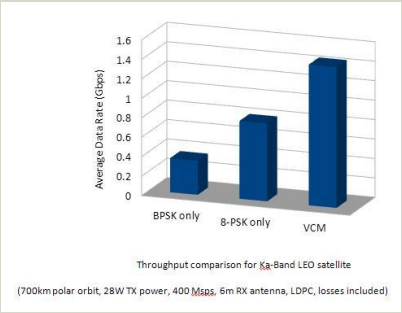
Images



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Project Image Variable and Adaptive Coded Modulation for Cognitive Networking
(https://techport.nasa.gov/image/1164)